Ryan Mechatronics LLC

SANDMAN Power Management
User Manual

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Release Notes

Title	Sandman		
Subtitle	Sandman User Manual		
Type	Manual		
Document number	UM3000		
Revision Index	**Date**	**Name**	**Status / Comments**
Initial Release	11/2012	MR	Initial release
A	3/1/2013	MR	• Updated input and output messages • Errata on stored byte capability noted (max is 1024 bytes vs. 4096) • Quickstart example added
B	3/22/2013	MR	• Updated ACK/NACK for better communication standard to X-Monkey • Added ABORT message to release Sandman from data storage or playback modes
C	12/22/2013	MR	• Cleanup on some messages. • Added Generic Sleep Message for generic wake up time • Only applies to SW version 1.1 (and higher)

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1. Introduction

The Sandman is a power management and data storage electronic board that allows you to effectively turn electronic hardware off for a specified amount of time, then have it turn back on. During the power down phase, current draw to the Sandman board is approximately 100 micro-amps. Sandman can control power to systems from 3.3V up to 20V while allowing up to 1.8 amps of current.

Up to 1k of data can be stored in nonvolatile memory on Sandman before turning power off, allowing your system to save system status and other information for use after power has returned.

The communication interface is via a 3.3V level UART with simple command structure.

The Sandman is intended for use in remote sensing applications that require strict power management to operate effectively.

1.1 Limitations

The unit, like any IMU / AHRS, can be pushed beyond the limits of its ability to sense any of the measurements it needs to operate correctly. The following list includes results that are known to occur if operation exceeds the limits listed later in this document.

1.1.1 User Responsibility

Accidental programming of an incorrect wake-up can result in a system that goes to sleep…and stays asleep. Please be careful and test your system thoroughly before deployment.

1.2 Theory of Operation

The Sandman integrates low resistance power circuitry, a low power real time clock unit and a CPU capable of deep power down modes in a single package that allows users to:

- Control the voltage supply to a separate system
- Store data to nonvolatile flash
- Turn off power to another system or the host system with automatic wake up

2. Specifications and Characteristics

Presented in this section are the sensor and system specifications for the Sandman. All parameters specified are @ VDD = 5.0 V and Ta = 25°C unless otherwise noted.

2.1 Performance Specifications

Characteristics	Conditions	Min	Typical	Max	Units
Memory					
Size	NVM storage available for user	0	64	2944	bytes
Communication					
UART characteristics	115,200 baud, 8-N-1	-	-	-	-

- Specifications are subject to change at any time without notice

2.2 Electrical Characteristics

Characteristics	Conditions	Min	Typical	Max	Units
Power					
Supply Voltage Range	V_{dd} Referenced to GND	3.3	5	20	V
Current, maximum pass thru to load	Maximum to load on output	0	-	1.8	A
Support circuitry, normal operation	System operating and awake		4.5		mA
Support circuitry in deep sleep	System in deep sleep, load output turned off		105		uA

- Specifications are subject to change at any time without notice

2.3 Absolute Maximum Ratings

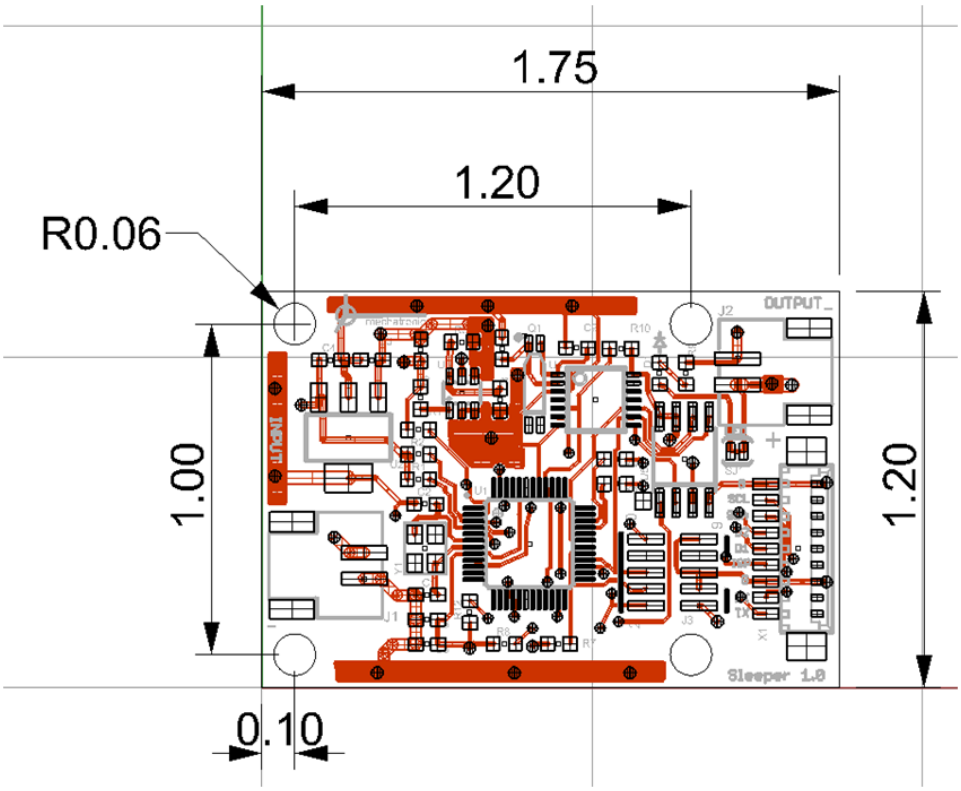
Parameter	Rating
V_{dd}	-0.3V to +20V
Operating Temperature Range	-40°C to +85°C
Storage Temperature Range	-55°C to +125°C

- Specifications are subject to change at any time without notice

Stresses above those listed under the Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at or near these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect device reliability.

2.4 Mechanical and Pin Assignments

2.4.1 Dimensions



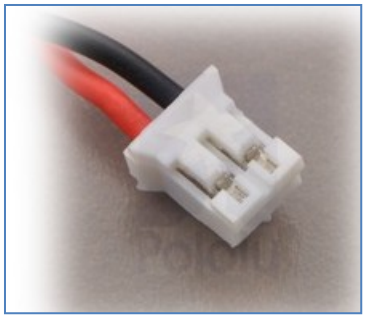
All units shown in inches

2.4.2 Recommended Connectors

2.4.2.1 Power In / Out

The Input and Output power connectors are identical. They are JST connector part S2B-PH-SM4-TB(LF)(SN) (Digikey P/N: 455-1749-1-ND).

There are many mating options for this connector, but an easy method is to purchase pre-crimped / built mating cables. An example of this is Pololu item 1116 http://www.pololu.com/catalog/product/1116 which is a connector and 14cm wire length. For reference, a picture of this connector is shown here:



2.4.2.2 Communications Connector (X1)

The communications connector has a set of connections for discrete I/O and communication. This connector is a 9 pin Molex socket. The mating connector for this is Digi-Key part number WM1727-ND, but this is just the connector housing. Pre-crimped wires can be found at Newark, part number 06-66-0013. For reference, a picture of this connector is shown here:

2.4.3 Pin Assignments

Table 1 – Power In/Out Connector Pin Assignments

Pin #	Pin Name	I/O	Pin Connection Required for Typical Operation?	Description
1	Vin	N/A	X	Or Vout if output connector
2	GND	N/A	X	

Table 2 – Communication (X1) Pin Assignments

Pin #	Pin Name	I/O	Pin Connection Required for Typical Operation?	Description
1	TX	O		UART com from Sandman 3.3V level
2	RX	I	X	UART com to Sandman 3.3V level
3	GND	N/A	X	Ground
4	ISP	I		Hold low upon power for reprogramming of unit (not standard)
5	DIO1	I		TBD
6	DIO2	I		TBD
7	SDA/DIO3	I		TBD
8	SCL/DIO4	I		TBD
9	GND	N/A		Ground (redundant to pin 3)

3. Hardware Integration

Presented in this section are selected hardware interface comments to help ease integration of the unit in the end user system.

3.1 Power

3.1.1 Input Power

The module operates off the input power voltage. On board circuitry operates at 3.3V levels. However, up to 20V may be applied at this connector.

The system draws very little power; typically it will require less than 5 mA of supply for operation when not in sleep mode.

3.1.2 Output Power

The module outputs the input power voltage when the unit is programmed to allow this output. When the unit goes to sleep, this output power is turned off.

3.2 Communication Interface

The module utilizes the X1 pins to command the unit and receive status. These pins are described here.

3.2.1 Pin 1 - TX

Output data from the module.

3.2.2 Pin 2 - RX

Commands to the module

3.2.3 Pin 3 and Pin 9 - Ground

Ground pins for signal use.

3.2.4 Pin 4 - ISP

In system programming pin. Pull low upon boot to load new code via UART.

3.2.5 Pin 5 - DIO1

TBD

3.2.6 Pin 6 – DIO2

TBD

3.2.7 Pin 7 – DIO3

TBD

3.2.8 Pin 8 – DIO4

TBD

3.3 Communication

Sandman has two means of communication - a standard UART and an I2C port.

Currently, the I2C port is inactive, but may be active as a slave device in future software releases.

3.3.1 UART

The UART is a 3.3V level interface. The unit does not use hardware handshaking. It is always 8 bits, no parity, and one stop bit (8-N-1). Do NOT interface with a standard RS-232 port, as the voltages on that port will damage the unit. An external adapter that uses 3.3V to convert to RS-232 levels can be powered from the onboard 3.3V regulator.

Standard operation is at 115k baud.

3.3.2 I2C Port

The I2C bus will be configured as a master device. Currently, it is not implemented, but future software revisions may include this.

3.4 Power Status LED

There is one (1) informational LED on the unit. This LED is for test only, and can be disconnected by cutting the LED trace solder jumper. The LED pulls an extra 0.5 mA at 5V during normal operation, so cutting this trace is good practice for energy saving purposes.

4. Software Interface

The hardware com interfaces have been described already. Details on software setup and communication are presented here.

4.1 Basic Message Structure

Input and Output messages from the unit are identical. Both include header and checksum and other information to protect data integrity and allow easier decoding by the end user.

4.1.1 Message format

Both input and output messages have a defined structure that consists of the following:

- (2) header bytes (0xAE 0xAE)
- (1) Message length byte
- (1) Message ID byte
- (xxx) Payload bytes (varies with message)
- (1) Checksum byte

The checksum byte is a LRC checksum calculated for the entire message, including header bytes, length, id, and data bytes. Details and code for calculating this checksum are provided later in this section.

4.1.2 Number Formats

Much of the data messages use single bytes and unsigned integers, which are typically easy to understand. A number format list is presented here for clarity on number formats however.

All floating point values are transmitted in IEEE754 single precision.

Table 3 - Number Formats

Abbreviation	Type	Size (bytes)	Comment	Min/Max
U1	Unsigned char	1		0 … 255
I1	Signed char	1	2's complement	-128 … 127
X1	Bitfield	1		n/a
U2	Unsigned short integer	2		0 … 65535
I2	Signed short integer	2	2's complement	-32768 … 32767
X2	Bitfield	2		n/a
U4	Unsigned long	4		0…4,294,967,295
L4	Signed long	4	2's complement	-2,147,483,648 … 2,147,483,647
R4	IEEE 754 Single Precision	4		-1*2^127 … 2^127
CH	ASCII encoded	1		

4.1.3 LRC Checksum Code

The checksum calculated for outgoing messages is an 8 bit Longitudinal Redundancy Check (LRC) code. C code to compute the entire checksum is shown below.

```
unsigned char calculateLRC(const unsigned char *buf, unsigned int n)
{
 unsigned char checksum = 0;
 while(n>0){
  checksum += *buf++;
  n--;
 }
 return ((char) -checksum );
}
```

4.1.4 ACK / NACK Response

A properly formatted message that is accepted by the module will be responded to with an ACK or NACK message. This message follows the same format as other messages.

4.1.4.1 Useful Code Structures

The following structures are useful for the setting and reading of data from the module.

4.1.4.2 TIME Structure

The following C structure is used for both setting and reading time from the unit. This is 27 bytes.

```
typedef struct
{
  unsigned char hun_sec;    //Hundreds of seconds
  unsigned char tenth_sec;  //Tenths of seconds
  unsigned char sec;      //Seconds
  unsigned char ten_sec; //Tens of seconds
  unsigned char min; //Minutes
  unsigned char ten_min; //Tens of minutes
  unsigned char st; //Oscillator start bit
  unsigned char hour; //Hours
  unsigned char ten_hr; //Tens of hours (use with 24 hr time)
  unsigned char AMPM; //10 hour AM/PM
  unsigned char TIMEFORMAT; //If set, 24 hr time.  If cleared, 12 hour time
  unsigned char CALSGN; //Calibration sign
  unsigned char day; //Day
  unsigned char VBATEN; //Vbat enable
  unsigned char VBAT; //Vbat switched
  unsigned char OSCON; //Oscillator on flag
  unsigned char date; //date
  unsigned char ten_date; //Tens of date
  unsigned char month; //Month
  unsigned char ten_month; //Tens of month
  unsigned char lp; //leap year
  unsigned char year; //year
  unsigned char ten_year; //Tens of year
  unsigned char CTRL_REG; //control register
  unsigned char CALIBRATION; //Should be zero if you ever set this
  unsigned char WATCHDOG; //Watchdog register
  unsigned char EVENT; //Event detect (unused)
} TimeKeeper_RTC_TypeDef;
```

4.1.4.3 ALARM Structure

The following C structure is used for both setting and reading alarms on the unit. It is 16 bytes long.

```
typedef struct
{
  unsigned char sec;      //Seconds
  unsigned char ten_sec; //Tens of seconds
  unsigned char min; //Minutes
  unsigned char ten_min; //Tens of minutes
  unsigned char hour; //Hours
  unsigned char ten_hr; //Tens of hours (use with 24 hr time)
  unsigned char AMPM; //10 hour AM/PM
  unsigned char TIMEFORMAT; //If set, 24 hr time.  If cleared, 12 hour time
  unsigned char day; //Day
  unsigned char ALMxIF; //Alarm Interrupt flag bit (must be cleared by software)
  unsigned char ALMxCx; //Alarm match conditions.  000=seconds, 001 = min, 010 = hrs, 111 = sec, min, hr, day,
date, and month
  unsigned char ALMxPIN; //Alarm Output Pin config bit.  0 = IRQ pin.  1 = WDO pin.
  unsigned char date; //date
  unsigned char ten_date; //Tens of date
  unsigned char month; //Month
  unsigned char ten_month; //Tens of month
} TimeKeeper_ALARM_TypeDef;
```

5. Input Message Details

Shown in this section are specific input message requirements and details

5.1 Input Message Summary

The output messages from the unit are shown in this summary table:

Table 4. Sandman Message Input

Name	ID	Description
Ping	0x00	Communication check
Set Time	0x01	Sets time on unit. Time is lost if power to the module is removed (i.e. no battery backup)
Get Time	0x02	Retrieves the time from the unit
Set Alarm	0x03	Sets alarm on unit.
Get Alarm	0x04	Retrieves the alarm currently set on the unit
Store Data Start	0x05	Begins store data state. User data may be stored to NVM on the module in preparation of power down / sleep
Get Data	0x06	Starts data retrieval from NVM
GoToSleep	0x07	Goes to sleep, powers down. Will not engage if alarm time is prior to current time
EasySleep	0x08	Go to sleep for a specified amount of time from the current time. Does not require user to set current time, and will occur immediately upon receipt.
Abort Mode	0x09	Will stop current mode (store or read data) and return to normal mode. Should be used to abort Sandman if there is any possibility that the communication is suspected to be stalled.
Generic Sleep	0x0A	Go to sleep for arbitrary number of seconds, minutes, hours or days. Only one of these can be selected (i.e. no combination of seconds, minutes)
Date Sleep	0x0B	Go to sleep until a specific date and time. **(FUTURE PLANNED MESSAGE, NOT AVAILABLE CURRENTLY)**
Data Package	0x10	Special message containing data to write. The Store Data Start message has to be sent first indicating how many data packets are going to be sent before these will be accepted.
Clear Wakeup Flag	0x11	Clears the wakeup flag in the status. This flag is set when the unit has powered up from a wake condition to let the user know power went down.

5.1.1 PING (ID 0x00)

Message			Name		
Description			**PING**		
ID			**0x00**		
Length					
Type			Input Message		
Comment			**Pings the unit. Unit responds with ping output message, BIT message, and current time. Useful for software protocol test.**		
Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x01	0x00	See Below	XSUM
Byte offset	Number format	Scaling	Name	Units	Description
0	U1	-	N/A	-	Value not used, but required for valid message

This message forces a ping output message (0x00) as a response regardless of the package data.

5.1.2 SET TIME (ID 0x01)

Message			Name		
Description			**Set Time**		
ID			**0x01**		
Length					
Type			Input Message		
Comment			**Sets the unit time.**		
Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x1B	0x01	See Below	XSUM
Byte offset	Number format	Scaling	Name	Units	Description
0	Time Structure	-	Current Time	-	Current time from the unit.

This message sets the time on the unit. This is NOT held in memory if main power is removed to the module (no battery backup). It is maintained and incremented in deep sleep however.

5.1.3 GET TIME (ID 0x02)

Message			Name		
Description			**Get Time**		
ID			**0x02**		
Length					
Type			Input Message		
Comment			**Gets the unit time.**		
Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x01	0x02	See Below	XSUM
Byte offset	Number format	Scaling	Name	Units	Description
0	U1	-	N/A	-	Requests output message 0x02 from module

This message requests time from the unit via message 0x02.

5.1.4 SET ALARM (ID 0x03)

Message	Name
Description	**Set Alarm**
ID	**0x03**
Length	
Type	Input Message
Comment	**Sets the unit alarm**

Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x11	0x03	See Below	XSUM

Byte offset	Number format	Scaling	Name	Units	Description
0	Alarm Structure	-	Alarm	-	Desired alarm time for wakeup

This message sets the alarm on the unit. This is NOT held in memory if main power is removed to the module (no battery backup). It is maintained and incremented in deep sleep however.

Note that the Sandman timekeeping chip only allows these entries for ALMxCx bits in gALARM:

- 000 – Seconds match
- 001 – Minutes match
- 010 – Hours match (logic takes into account 12/24 operations)
- 011 – Day match. Generates interrupt at 12:00:00 AM
- 100 – Date match
- 101 – Unimplemented, do not use
- 110 – Unimplemented, do not use
- 111 – Seconds, Minutes, Hour, Day, Date and Month

Other combinations are invalid and but will not be indicated by a NACK. Recommend use of message 0x0A for generic sleep if EasySleep values are not acceptable.

Follow this up with the GoToSleep message to power down.

5.1.5 GET ALARM (ID 0x04)

Message	Name
Description	**Get Alarm**
ID	**0x04**
Length	
Type	Input Message
Comment	**Gets the unit time.**

Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x01	0x04	See Below	XSUM

Byte offset	Number format	Scaling	Name	Units	Description
0	U1	-	N/A	-	Requests output message 0x04 from module

This message requests alarm from the unit via message 0x04.

5.1.6 STORE DATA (ID 0x05)

Message			Name		
Description			**Store Data**		
ID			**0x05**		
Length					
Type			Input Message		
Comment			**Stores the data for retention during power down**		
Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x02	0x05	See Below	XSUM
Byte offset	Number format	Scaling	Name	Units	Description
0	U2	-	Bytes to write	-	Number of bytes to write (maximum 2944)

After successful receipt of this message, the user is required to send the number of bytes specified in a stream to the unit. No other operation will occur until all bytes have been received.

This message stores a stream of data to the unit to be saved during power down. All other data on the unit is erased / overwritten by this message.

5.1.7 GET DATA (ID 0x06)

Message			Name		
Description			**Get Data**		
ID			**0x06**		
Length					
Type			Input Message		
Comment			**Requests data retrieval**		
Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x02	0x06	See Below	XSUM
Byte offset	Number format	Scaling	Name	Units	Description
0	U2	-	Bytes to read	-	Number of bytes to read via output message 0x06

This message requests stored data from the unit via message 0x06.

5.1.8 GOTOSLEEP (ID 0x07)

Message			Name		
Description			**Go To Sleep**		
ID			**0x07**		
Length					
Type			Input Message		
Comment			**Goes to sleep, wakes on alarm**		
Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x02	0x07	See Below	XSUM
Byte offset	Number format	Scaling	Name	Units	Description
0	U2	-	Sleep pause	-	Milliseconds to delay before going to sleep

This message puts the unit to sleep after the number of milliseconds in the payload.

5.1.9 EASY SLEEP (ID 0x08)

Message			Name		
Description			**Easy Sleep**		
ID			**0x08**		
Length					
Type			Input Message		
Comment			**Easy method for setting the unit to sleep**		
Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x01	0x08	See Below	XSUM
Byte offset	Number format	Scaling	Name	Units	Description
0	U1	-	Type of Easy Sleep	-	Easy sleep

This message puts the unit to sleep immediately for the specified amount of time.

Type of Easy Sleep:
0 = 10 seconds
1 = 1 minute
2 = 1 hour
3 = 3 hour
4 = 12 hour
5 = 24 hour

5.1.10 ABORT MODE (ID 0x09)

Message			Name		
Description			**ABORT MODE**		
ID			**0x09**		
Length			**0**		
Type			Input Message		
Comment			**Aborts the store data / read data modes if in effect.**		
Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x00	0x09	See Below	XSUM

5.1.11 GENERIC SLEEP (ID 0x0A)

Message			Name		
Description			**Generic Sleep**		
ID			**0x0A**		
Length					
Type			Input Message		
Comment			**Generic method for setting the unit to sleep**		
Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x02	0x0A	See Below	XSUM
Byte offset	Number format	Scaling	Name	Units	Description
0	U1	-	Choice of sleep	-	Choice for sleep (see below)
1	U1	-	Time to sleep	Seconds, Minutes, Hours, Days	Actual time to sleep

This message puts the unit to sleep immediately for the specified amount of time. The first payload entry represents the choice of sleep units. The following list shows the valid selections:

Choice for sleep units:
0 = seconds
1 = minutes
2 = hours
3 = days (note: triggering on days will wake the unit up at 12:00 a.m. on the next day rollover, NOT at the current time plus one day)

For example:
To set a 7 hour wakeup, field 0 = 2 and field 1 = 7.
To set a 2 day wakeup, field 0 = 3 and field 2 = 2;

Combinations of 3 hours and 20 minutes are invalid due to timekeeper chip limitations. In a situation like this, it is recommended to sleep for 3 hours, wakeup and immediately send an additional 20 minute sleep.

This message puts the unit to sleep immediately after receipt, no delay.

5.1.12 DATA PACKAGE (ID 0x10)

Message	Name
Description	**Data Package**
ID	**0x10**
Length	**64**
Type	Input Message
Comment	**Sends a 64 byte packet of data for storage after Storage Mode was initiated with message 0x05**

Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x40	0x10	See Below	XSUM

Byte offset	Number format	Scaling	Name	Units	Description
0	U1	-	64 bytes of data to send	-	64 bytes of data to send. Keep sending this message with different data packets until all data has been transmitted.

5.1.13 CLEAR WAKEUP FLAG (ID 0x11)

Message	Name
Description	**CLEAR WAKEUP FLAG**
ID	**0x11**
Length	**0**
Type	Input Message
Comment	**Clears the status flag indicating wakeup.**

Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x00	0x11	None	XSUM

6. Output Message Details

Shown in this section are the specific message descriptions for output messages from the unit.

6.1 Output Messages

The output messages from the unit are shown in this summary table:

Table 5. Sandman Message Output

Name	ID	Length	Description
Ping	0	4	"I'm alive" message
Reserved	1	-	-
UNIT TIME	2	27	Time in module
Reserved	3	-	-
UNIT ALARM	4	17	Alarm in module
Reserved	5	-	-
GET DATA	6	Varies	Retrieves stored data from module
Reserved	7	-	-
Reserved	8	-	-
ACK	0x21	0	Accepted message response
NACK	0x63	0	Rejected message response

Note: The length shown in this section is the package / payload length for that message. It does not include the header characters (0xAEAE), length byte, device ID byte, message ID byte, or checksum byte.

The messages available with content are follow the same format as the input messages with respect to header, id, payload and checksum.

6.1.1 PING (ID 0x00)

Message	Name
Description	**PING**
ID	**0x00**
Length	
Type	Output Message
Comment	**Response to ping request**

Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x04	0x00	0xMM 0xNN 0xPP 0xZZ	XSUM

This message is in response to the 0x00 ping request.

The three bytes sent down (0xMM, 0xNN, and 0xPP) represent the software version on board. Major.Minor.Revision = MM.NN.PP.

The last byte 0xZZ represents the status of the unit:

- 0x00 = Unit has powered up and not recovered from a deep sleep event (or deep sleep event was cleared)
- 0x01 = Unit has powered up from a deep sleep event

Note that ONLY message 0x11 or a complete power removal from the input will clear this flag.

6.1.2 RESERVED (ID 0x01)

Unused.

6.1.3 UNIT TIME (ID 0x02)

Message	Name
Description	**Unit Time**
ID	**0x02**
Length	
Type	Output Message
Comment	**Time currently residing in the module**

Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x1B	0x02	See Below	XSUM

Byte offset	Number format	Scaling	Name	Units	Description
0	Time Structure	-	Current Time	-	Current time from the unit.

This message is a response to the request time message.

6.1.4 RESERVED (ID 0x03)

Unused.

6.1.5 UNIT ALARM (ID 0x04)

Message	Name
Description	**Unit Alarm**
ID	**0x04**
Length	
Type	Output Message
Comment	**Gets the unit time.**

Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x11	0x04	See Below	XSUM

Byte offset	Number format	Scaling	Name	Units	Description
0	Alarm Structure	-	Alarm	-	Desired alarm time for wakeup
16	U1	-	Alarm Type	-	Alarm type to wake up on: • Seconds match • Minutes match • Hours match • Full date match

This message is a response to the request alarm message.

6.1.6 RESERVED (ID 0x05)

Unused.

6.1.7 GET DATA (ID 0x06)

Message	Name
Description	**Get Data**
ID	**0x06**
Length	**0x42**
Type	Output Message
Comment	**Data stored in NVM**

Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0x42	0x06	See Below	XSUM

Byte offset	Number format	Scaling	Name	Units	Description
0	U2	-	Bytes left to recover	-	Number of bytes remaining to transmit from the requested number (count is not including this data packet)
2	U1	-	Data packet	-	64 byte packet of data requested (multiple messages increment thru

					data until “bytes being recovered’ is finished).

This message is a response to request for stored data from the unit via message 0x06. It will be output at 100 msec intervals containing 64 bytes of data from the requested data set until all data has been transmitted.

6.1.8 RESERVED (ID 0x07)

Unused.

6.1.9 RESERVED (ID 0x08)

Unused.

6.1.10 ACK (ID 0x21)

Message	Name
Description	**ACK**
ID	**0x21**
Length	**0**
Type	Output Message
Comment	**Accepted message**

Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0	0x21	None	XSUM

This message is a response to incoming messages indicating that the checksum passed.

6.1.11 NACK (ID 0x63)

Message	Name
Description	**NACK**
ID	**0x63**
Length	**0**
Type	Output Message
Comment	**Rejected message**

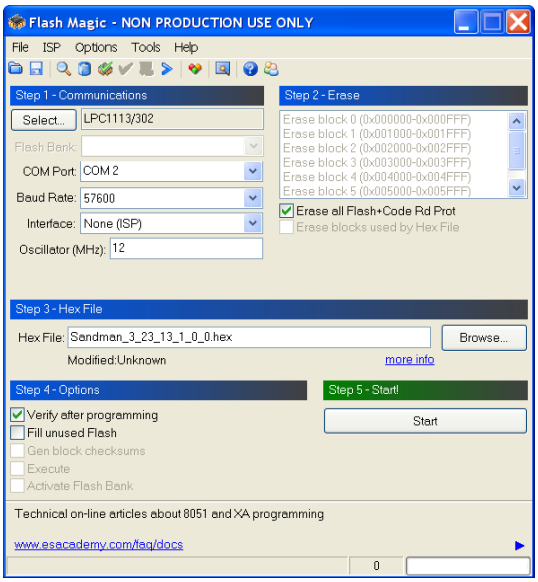
Message Structure	**Header**	**Payload Length**	**Message ID**	**Payload**	**Checksum**
	0xAE 0xAE	0	0x63	None	XSUM

This message is a response to incoming messages indicating that the checksum was rejected.

7. Software Reprogramming

The Sandman board can be reprogrammed in the field if necessary. In order to accomplish this, the user will have to pull down the ISP pin upon powering up. This puts the processor into boot loader mode, and new firmware can be uploaded via the serial port. Steps to load a new Hex file (firmware image) into the Sandman board

1) Download and install the latest version of *FlashMagic* from this site: (http://www.flashmagictool.com/)
2) Power down Sandman
3) Plug USB node or other USB to serial converter into Sandman
   a. See Table 2 for connector details. Port is 3.3V level.
4) Connect pin 4 (ISP) to pin 3 or pin 9 (GND) on connector X1 (again, see Table 2 for connector specifics) and **KEEP IT CONNECTED FOR THE NEXT STEP!**
5) Power up Sandman
6) Release ISP to Ground connection from step 4.
7) Run *FlashMagic* and reprogram
   a. Open settings file (.fms), or if .fms file is not available, select settings shown below



   b. Change COM port to your com port
   c. Change path to .hex file to where you stored the hex file to download
   d. Press the “start” button, it will flash and verify
   e. If it still fails, try powering the unit again as listed above
   f. If it still fails, drop the baud rate to 57600
8) Close *FlashMagic*
9) Power board down
10) Power up without any buttons pressed and verify new code is running
   a. This can be done with the serial port connected if you send the ping message:
      i. 0xAE 0xAE 0x01 0x00 0x00 0xA3
   b. The response will be the status message showing the software major, minor and revision number (in hex)

8. Software Release Notes

Software version descriptions can be found here.

Table 6 – Software Revision

Major	Minor	Build	Description
1	0	0	Initial release
1	1	0	Added generic sleep support, fixed some bugs in advanced handling

9. Appendix A: Quick Start Example

The sequence below shows how you can interact with Sandman to store data, turn power off to your system, and then return power an hour later.

1. Connect hardware correctly (TX/RX to Sandman from host processor, power to entire system routed thru Sandman)
2. From your microprocessor, send message **0x05** (Store Data) with any data bytes you want to save in memory while the system
    a. After receipt of message 0x05, an ACK response **0x21** will be sent
    b. It is the users responsibility to then send the number of bytes specified in message 0x05 to Sandman.
    c. This is done using message **0x10**.
3. As a check the user can send message **0x06** (Get Data) to retrieve blocks of 64 bytes and compare to verify the bytes were written correctly.
4. Send message **0x08** (Easy Sleep) with a payload value of "0" to force the unit into a 10 second (demo) sleep mode.
    a. The unit will immediately cut power to the system and go into power savings mode
5. When the unit wakes up…
    a. User will see the ping message (**0x01**) from Sandman now indicates that the unit woke up from a power down event
6. User can recover stored data using message **0x06**.